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(56) Documents cited

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(58) Field of search

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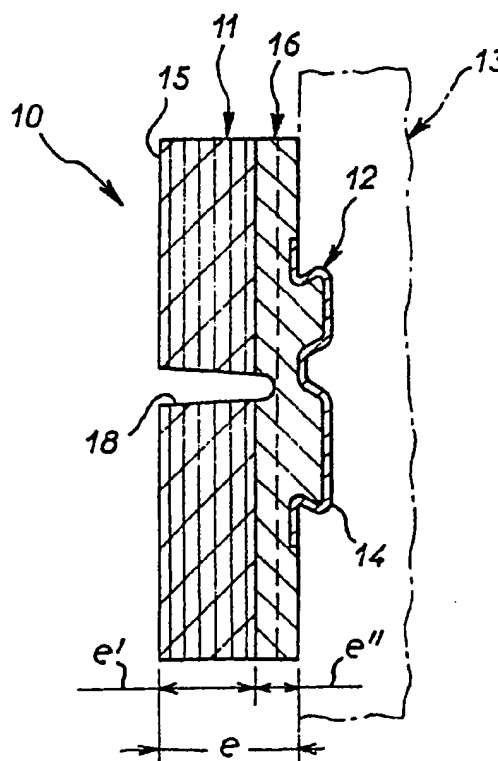
INT CL<sup>5</sup> B61H, F16D

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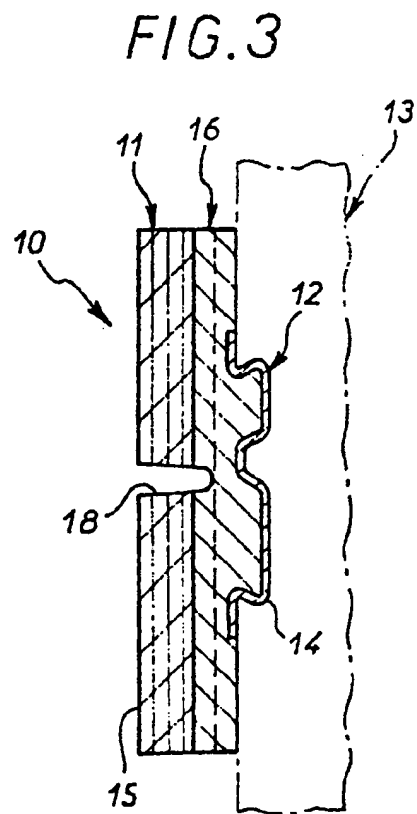
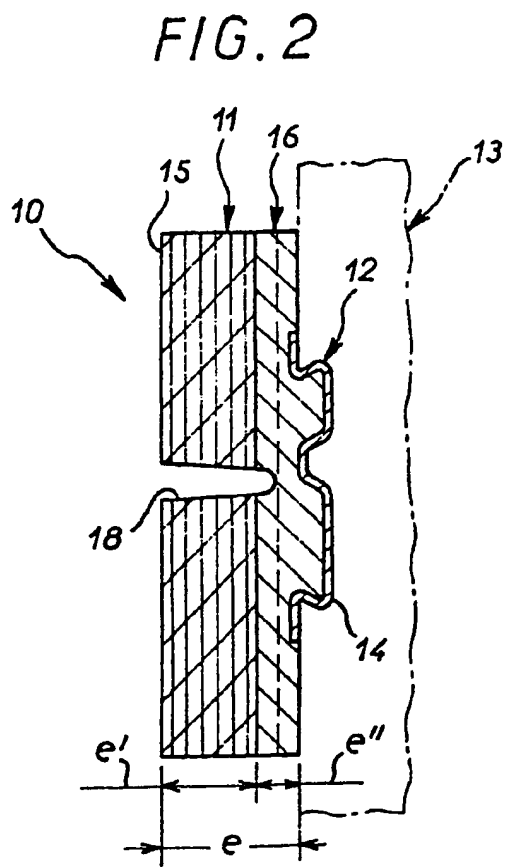
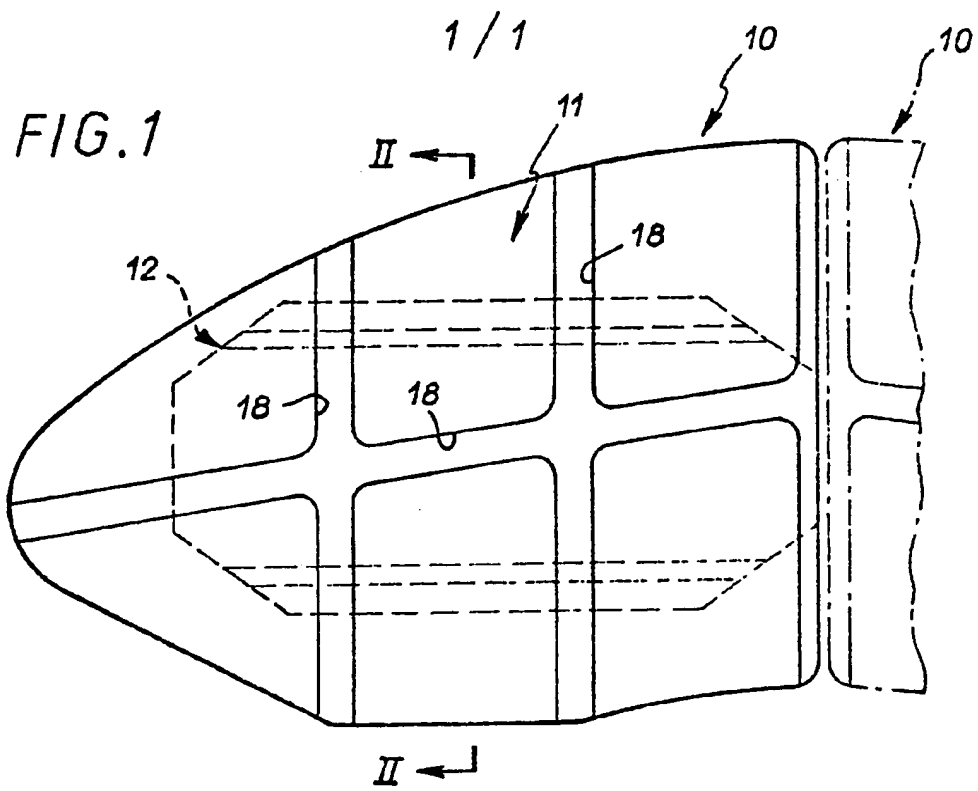
(54) Disc brake pad for railway use

(57) A disc brake pad for railway use comprises a friction lining (11) carried by a sole plate (12), wherein the friction lining (11) is made of a friction material having a modulus of elasticity under compression greater than 11,000 daN/cm<sup>2</sup> and, conjointly, interposed between it and the sole plate (12) there is an underlayer (16) made of material having a modulus of elasticity under compression less than 1,000 daN/cm<sup>2</sup>.

FIG. 2



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"Disc brake pad for railway use"

The present invention relates in a general manner to disc brake pads for use on railway vehicles.

As is known, disc brakes, known to have been used in automobiles for a long time, are nowadays more and more often employed for railway vehicles where they are tending to replace the band brakes used until now to equip the appropriate vehicles.

As in the case with automobiles, the disc brakes for railway vehicles employ two brake pads which, being disposed respectively one on each side of the disc and being subject to pressure operated control means carried by a squeezing device or a clamp, are usually each divided circumferentially into two half-plates each comprising a friction lining by which they are adapted to be applied against the disc and a sole plate which carries the said friction lining and by which they are themselves adapted to be attached to a support which is fixed relative to the disc.

However, for use on railway vehicles, the conditions for operating such disc brakes are very specific.

First of all, the pressure, provided by compressed air, at which the friction lining of the brake plates is applied to the disc is relatively low.

Conjointly, the linear speed at the interface between the said friction lining and the disc is, on the contrary, much higher.

Now, the energy consumed during braking is dissipated as heat and the rise in temperature which results from this has, in the case of the disc, the effect of expanding the constitutive material whether this be cast iron or steel.

Repeated braking thus subjects the disc alternately to heating and cooling.

If, during such repeated braking the heating is sufficiently great, the limit of elasticity in traction of the material may be reached and fatigue fractures may then finally appear at its surface to the detriment of its working life and thus of safety.

To limit the heating on braking it is important to decrease the average temperature at the interface between the friction lining and the disc.

It is important, therefore, to obtain a good distribution of the heat and, consequently, to ensure maximal contact between the said friction lining and the disc.

Thus, and independently of all other considerations, from this point of view it is particularly desirable, in the case of disc brakes for railway use that, despite the relatively low application pressure to which it is subjected, the friction lining should match the disc as closely as possible and be applied to the latter over all its surface.

It therefore seems desirable, from this point of view, that the constitutive friction material of the said friction lining should be relatively resilient or, in other words, that perpendicularly to the friction interface, the friction material should have a relatively low modulus of elasticity under compression.

A modulus of elasticity under compression of about 6,800 daN/cm<sup>2</sup> is generally regarded as suitable for this purpose for railway use.

However, it turns out that with a friction material having such a modulus of elasticity under compression, a very large decrease in efficiency is observed on braking when the braking occurs in a humid atmosphere such as may be the case when it rains or when it snows.

Usually about 30 to 40%, this decrease in efficiency, measured by stopping distance, may reach 100%.

This effect, still not well understood, is in general attributed to the presence of a film of water which then forms at average speeds between the friction lining and the disc.

To alleviate this disadvantage it has been proposed to employ, to form the friction lining, a relatively hard friction material, such as is already known for use with automobiles.

In practice, to retain a sufficiently large friction coefficient in a humid atmosphere, it is generally agreed that the said friction material should have a modulus of elasticity under compression greater than 11,000 daN/cm<sup>2</sup>.

The friction linings made from such a friction material are presumed to break the film of water when such a film of water tends to form.

However, they have the disadvantage of becoming applied only very imperfectly to the disc.

This results, on braking, in an irregular heating of the latter with the danger that, becoming too great locally, this heating leads, as indicated previously, to the formation of fractures.

Consequently, for a disc brake for railway use, two incompatible and contradictory requirements usually have to be satisfied for the friction material constituting the friction lining of brake plates, the said friction material having to be relatively resilient and relatively hard at the same time.

In a general manner, the object of the present invention is a device making it possible to overcome this difficulty easily.

More specifically, its object is a disc brake pad for railway use of the type comprising a friction lining carried by a sole plate and characterized in a general manner in that, conjointly, on the one hand the friction lining is made of friction material having a high modulus of elasticity under compression and in that, on the other hand, interposed between it and the sole plate there is an underlayer made of material having a low modulus of elasticity under compression.

In practice, the modulus of elasticity under compression of the friction material constituting the friction lining is selected to be greater than  $11,000 \text{ daN/cm}^2$  and the modulus of elasticity of the material constituting the underlayer is chosen to be less than  $1000 \text{ daN/cm}^2$  and is preferably about 800 to  $900 \text{ daN/cm}^2$ .

Overall, other conditions being equal, the absolute deformation of the assembly formed by the friction lining and the underlayer is then equivalent to that of a friction lining having the same thickness as the said assembly and made of a friction material of which the modulus of elasticity under compression is less than  $7,000 \text{ daN/cm}^2$  and is preferably about  $6,800 \text{ daN/cm}^2$ .

Thus, the disc brake pad in accordance with the invention has at its surface a friction lining the friction material of which is sufficiently hard to prevent a large decrease in efficiency in a humid atmosphere and, conjointly, it comprises in its interior, beneath this friction lining, an underlayer the constitutive material of which is sufficiently resilient for the said friction lining to match the shape of the disc optimally under all circumstances.

In practice, with the disc brake pad in accordance with the invention the decrease in efficiency in a humid atmosphere is less than 20%, and often remains less than 15%.

Certainly it is already known, in particular from American patent No. 3 751 330, to employ an underlayer of a relatively resilient material in a brake element.

However, this American patent relates to a shoe for a band brake.

Furthermore, and above all, in that patent the essential purpose of the underlayer is to lead to a relatively high resistance to tangential shearing relative to the friction interface, as is confirmed by the presence of threads in the material.

In fact, and essentially, it relates to the avoidance of detachment of the friction lining from the sole plate which bears it under the dynamic action of vibrations.

The disc brake pad for railway use according to the invention is not concerned with this at all, but, on the contrary, an attempt is made to achieve some elasticity perpendicularly to the friction interface in order to obtain a good adaptation to one another of the surfaces defining the latter.

Embodiments of the invention are described, by way of example, with reference to the attached drawings in which:

Figure 1 is a view in elevation of a disc brake pad in accordance with the invention;

Figure 2 is a view in transverse cross-section along the line II-II in Figure 1;

Figure 3 is a view in transverse cross-section similar to that in Figure 2 but for an alternative embodiment;

As is shown in these Figures, in an already known manner the disc brake pad 10 according to the invention, which is designed to equip railway vehicles, comprises, overall, a friction lining 11 carried by a sole plate 12.

For example, and as shown, the sole plate 12 extends only over part of the surface of the friction lining 11, at the back of the latter, and to enable the assembly to be fixed to some sort of support 13, shown partially schematically by chain-dotted lines in Figures 2 and 3, it itself comprises in its rear surface a groove 14 adapted for dovetail type mounting on the said support 13.

The corresponding arrangements being themselves well known and not forming part of the present invention they will not be described in more detail here.

In a manner also known in itself, and as shown schematically by chain-dotted lines in Figure 1, the disc brake pad 10 in accordance with the invention is usually paired end to end with another following a circumference of the disc in question.

According to the invention, and conjointly, the friction lining 11 is made of a friction material having a high modulus of elasticity under compression perpendicularly to the surface at which it is adapted to be applied against a disc, not shown, and interposed between the said friction lining 11 and the sole plate 12 there is an underlayer 16 made of material having a low modulus of elasticity under compression.

Preferably the modulus of elasticity under compression of the friction material constituting the friction lining 11 is chosen to be greater than 11,000 daN/cm<sup>2</sup> and the material constituting the underlayer 16 is chosen such that, other conditions being equal, the absolute deformation of the assembly formed by the said friction lining 11 and the said underlayer 16 perpendicularly to the surface 15 of the friction lining 11 should be equivalent to that of a friction lining 11 having the same thickness  $e$  as the said assembly and being made of a friction material of which the modulus of elasticity under compression  $E$  is less than 7,000 daN/cm<sup>2</sup> and is preferably about 6,800 daN/cm<sup>2</sup>.

Let  $e'$  be the thickness of the friction lining 11 and  $E'$  be the

modulus of elasticity under compression of the material of which it consists.

Conjointly, let  $e''$  be the thickness of the underlayer 16 and  $E''$  be the modulus of elasticity under compression of the material of which it consists.

The following relationship exists between these various parameters:

$$E'' = \frac{e''}{\frac{e}{E} - \frac{e'}{E'}}$$

Taking into account the numerical values of  $E$  and  $E''$  quoted above for the modulus of elasticity under compression, this equation makes it possible to discover the approximate magnitude of the modulus of elasticity under compression  $E''$  which the material constituting the underlayer 16 should possess depending on the two thicknesses in question.

For example, the thickness  $e'$  of the friction lining 11 may be twice that,  $e''$ , of the underlayer 16, as shown in Figure 2. Alternatively, as in Figure 3, it may be about the same as that of the underlayer.

However, overall, the modulus of elasticity under compression  $E''$  which the material constituting the underlayer 16 should possess is in practice always less than  $1000 \text{ daN/cm}^2$  and is often about 800 to 900  $\text{daN/cm}^2$ .

Whatever it may be, it is preferably determined such that, at total wear of the friction lining 11, the deformation should still be sufficient.

Preferably, also, the underlayer 16 contains rubber or a composite material having an elastomeric matrix.

Measured by weight, and calculated as pure rubber, the rubber content of the underlayer is between 10% and 30% and preferably it is about 15%.

Preferably, too, when the underlayer 16 contains a filler material this material does not contain threads.

Hereinafter a possible composition of the friction material constituting the friction lining 11 and a possible composition of the material constituting the underlayer 16 is given, by way of non-limiting example.

A. Friction lining 11:

	% by weight
Steel wool	23.3
Rock wool	10
Nitrile rubber	3.95
Sulphur	1.05
Phenol formaldehyde resin	10.95
Hexamethylenetetramine	0.85
Brass turnings	19.15
Iron oxide	12
Coke from coal	10.7
Magnesia	7.5
Silicon carbide	0.55
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	100

B. Underlayer 16

	% by weight
Steel wool	40
Rock wool	15
Butadiene-styrene rubber	15
Sulphur	0.5
Zinc oxide	3.5
Magnesia	3
Phenol formaldehyde resin	1
Barytes	16
Iron oxide	3
Graphite	3
	<hr/>
	100

With such a composition the constitutive material of the underlayer 16 advantageously retains its dynamic resilient properties up to about 100°C, which is sufficient for most applications.

For specific applications corresponding to extreme conditions, as may be the case for braking high speed trains, a stronger rubber such as nitrile, ethylene acrylic or fluorinated elastomer, for example, is preferentially chosen, and preferably this rubber is reinforced for example by being combined with aramide fibres.

In the latter case, the constitutive material of the underlayer 16 retains its properties up to about 250°C.

In any case, the fibres present both in the friction lining 11 and in the underlayer 16, because of the manner in which the latter are made, have a length at most equal to 1 or 2 cm.

Thus threads are not involved at all.

If so desired, the friction lining 11 and the underlayer 16 may be moulded and vulcanized together, directly on the sole plate 12.

In this case, the transformation temperatures of their respective constitutive materials should preferably be very close to one another.

For example, the following procedure may be used.

First of all a mixture A corresponding to the material desired for the friction lining 11 is obtained and so is a mixture B corresponding to the material desired for the underlayer 16.

For example, the mixture A is treated in a mixer comprising blades and knives for about 16 minutes and the mixture B is treated in a kneading mixer for 13 minutes.

Alternatively the mixture B is treated in a kneading device into which a solvent is added to dissolve the rubber and, then pasty, it is then dried, then ground.

However they are prepared, they are then discharged into a mould in which the sole plate 12 has previously been positioned, first the mixture B to form a layer having as constant a thickness as possible, then the mixture A.

These mixtures A and B are then compressed by a piston at a pressure of 500 daN/cm<sup>2</sup> at ambient temperature or whilst heated.

Then the assembly is cured, in an oven, at 200°C for 5 hours, to polymerize the resins and vulcanize the rubbers.

The interface obtained between the friction lining 11 and the underlayer 16 at the end of this implementation process is then relatively irregular and uneven, the friction lining 11 and the underlayer 16 penetrating mutually into one another to form overlapping regions along the said interface, which favours resistance to shearing.

However, as an alternative to this implementation process, the friction lining 11 and the underlayer 16 may also be moulded and

vulcanized separately before being attached to one another, then being suitably fixed to one another by adhesion, for example.

Whatever the process may be, it is performed so that the friction lining 11 presents, preferably hollowed out in its surface 15, a grid-like network of grooves 18.

According to the invention these grooves 18 are sufficiently deep to also extend into the underlayer 16.

The friction lining 11 is thus subdivided into blocks 20 independent of one another, which favours the production of a good individual contact of each of the said blocks 20 on the associated disc.

In fact, the blocks 20 may then act independently of one another under the spring-like effect of the adjacent resilient underlayer 16.

CLAIMS

1. A disc brake pad for railway use, comprising a friction lining (11) carried by a sole plate (12), characterized in that, conjointly, the friction lining (11) is made of friction material having a high modulus of elasticity under compression, that is to say of a material of which the modulus of elasticity under compression is greater than 11,000 daN/cm<sup>2</sup>, and interposed between the said friction lining (11) and the sole plate (12) there is an underlayer (16) made of material having a low modulus of elasticity under compression, that is to say of a material of which the modulus of elasticity under compression is less than 1000 daN/cm<sup>2</sup>.

2. A disc brake pad according to claim 1, characterised in that the modulus of elasticity under compression of the underlayer is in the range 800 to 900 daN/cm<sup>2</sup>.

3. A disc brake pad according to claim 1 or 2, characterized in that the absolute deformation of the assembly formed by the friction lining (11) and the underlayer (16) is equivalent to that of a friction lining (11) having the same thickness as the said assembly and being made of a friction material of which the modulus of elasticity under compression is less than 7,000 daN/cm<sup>2</sup>.

4. A disc brake pad according to claim 1 or 2, characterized in that the absolute deformation of the assembly formed by the friction lining (11) and the underlayer (16) is equivalent to that of a friction lining (11) having the same thickness as the said assembly and being made of a friction material of which the modulus of elasticity under compression is about 6,800 daN/cm<sup>2</sup>.

5. A disc brake pad according to any preceeding claim characterized in that the underlayer (16) contains rubber.

6. A disc brake pad according to claim 5, characterized in that, measured by weight and calculated as pure rubber, the rubber content of the underlayer (16) is between 10% and 30%.

7. A disc brake pad according to claim 6, characterised in that the rubber content of the underlayer is about 15%.

8. A disc brake pad according to any one of claims 5 to 7, characterized in that the filler material which the underlayer (16) contains together with the rubber does not contain continuous threads.

9. A disc brake pad according to any one of claims 1 to 8, characterized in that the constitutive friction material of the friction lining (11) has a composition of the following type:

	% by weight
Steel wool	23.3
Rock wool	10
Nitrile rubber	3.95
Sulphur	1.05
Phenol formaldehyde resin	10.95
Hexamethylenetetramine	0.85
Brass turnings	19.15
Iron oxide	12
Coke from coal	10.7
Magnesia	7.5
Silicon carbide	0.55
	<hr/> 100

10. A disc brake pad according to any one of claims 1 to 9, characterized in that the constitutive material of the underlayer (16) has a composition of the following type:

	% by weight
Steel wool	40
Rock wool	15
Butadiene-styrene rubber	15
Sulphur	0.5
Zinc oxide	3.5
Magnesia	3
Phenol formaldehyde resin	1
Barytes	16
Iron oxide	3
Graphite	3
	<hr/>
	100

11. A disc brake pad according to any one of claims 1 to 10, characterized in that the friction lining (11) and the underlayer (16) are moulded and vulcanized together.

12. A disc brake pad according to any one of claims 1 to 10, characterized in that the friction lining (11) and the underlayer (16) are moulded and vulcanized separately before being attached to one another.

13. A disc brake pad according to any one of claims 1 to 12, characterized in that the friction lining (11) comprises a network of grooves (18) hollowed into its surface (15), the said grooves (18) also extending into the underlayer (16).

14. A disc brake pad substantially as hereinbefore described with reference to the accompanying drawings.

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

GB 9220446.0

**Relevant Technical fields**

(i) UK Cl (Edition K ) F2E (EHB)

(ii) Int Cl (Edition 5 ) B61H, F16D

**Databases (see over)**

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

**Search Examiner**

P T SQUIRE

**Date of Search**

20 NOVEMBER 1992

Documents considered relevant following a search in respect of claims 1-14

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	GB 1380501 (ABEX) see page 2 lines 81-93	1, 5, 11
X	GB 1359570 (SEMPERIT) see page 1 lines 39-50	1
X	GB 1111380 (BUDD) see page 2 lines 8-14	1
X	GB 527218 (BUDD) see page 2 lines 44-55	1, 5

Category	Identity of document and relevant passages	Relevant to claim(s).

### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

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**A:** Document indicating technological background and/or state of the art.

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